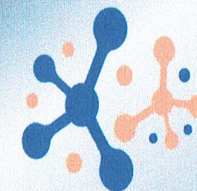




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By: Mokhtar MESSAAD

Co-authors: Djamel Ouzendja and Taieb Messaad

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Free vibration analysis of concrete gravity dams taking into account the dam—foundation-water interaction

Messaad Mokhtar*¹ Ouzandja Djamel², and Taieb Messaad³

¹ Laboratory of Hydraulic Developments and Environment LAHE , University of Biskra, Biskra, Algeria

² Laboratory of Materials and Mechanics of Structures (LMMS), University of Msila, Algeria

³ Department of Mechanics Engineering, University of Msila.

*Corresponding author E-mail: mokhtarmsd89@yahoo.com

ABSTRACT

Gravity dams are fluid – structure – soil interaction problems. One of the most important problems in evaluation of dynamic behavior of concrete gravity dams is soil-structure interaction phenomenon. A parametric study was performed in the present work to view the combined effect of soil foundation. The Oued Fodda concrete gravity dam located in Chlef (northwestern Algeria) is selected as an example.

Three approaches are adopted to investigate the soil-structure interaction phenomenon: the fixed support foundation, the massless soil foundation and the mass soil foundation and also the hydrodynamic pressure of the reservoir water is modeled as added mass using the Westergaard approach. As conclusion, it is clear that taking into account the soil structure interaction effect leads to an increase in the modal periods even if the reservoir water is present.

Keywords: *Soil-structure interaction, Modal behavior, fluid-structure interaction, Concrete gravity dams.*

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Introduction

There The response of a structure during an earthquake depends on the characteristics of the seismic signal, ground of foundation and of the structure itself. Thus, movement of the foundation is usually different from the movement in free field. This is due to the soil-structure coupling during the earthquake, this phenomenon is known as Soil-structure interaction.

The objective of this article is to perform a parametric study to see the effect of the phenomenon of soil-fluid-structure interaction on the behavior of “Oued Fodda” dam. For the modeling of the different cases of the dam in question, the finite element code ANSYS was chosen..

Numerical Models

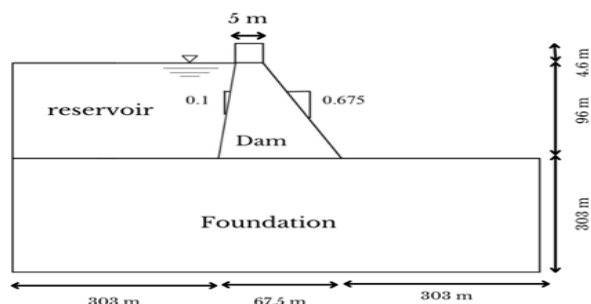


Fig. 1. Transverse section and dimensions

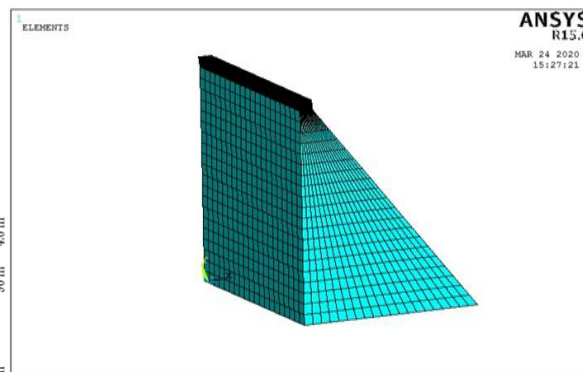


Fig. 2. Finite element discretization of dam-foundation system

Table 1. Material properties of Oued Fodda concrete gravity dam

Material	Material Properties		
	Modulus of Elasticity (MPa)	Poisson's Ratio	Mass Density (kg/m ³)
Dam	24600	0.20	2640
Foundation	20000	0.33	2000
Reservoir water	2070	0.49	1000

Three approaches are adopted to investigate the soil-structure interaction phenomenon:

The fixed support foundation.

The massless soil foundation, neglecting the mass of this foundation,

The mass soil foundation, taking into account the mass of this foundation ,

The dam-foundation soil structure is investigated using three 3D finite element models, The SOLID185 type element was used to model the body of the dam as well as the foundation soil.

Results and Discussion

The Figures shows a comparison between first periods for each model.

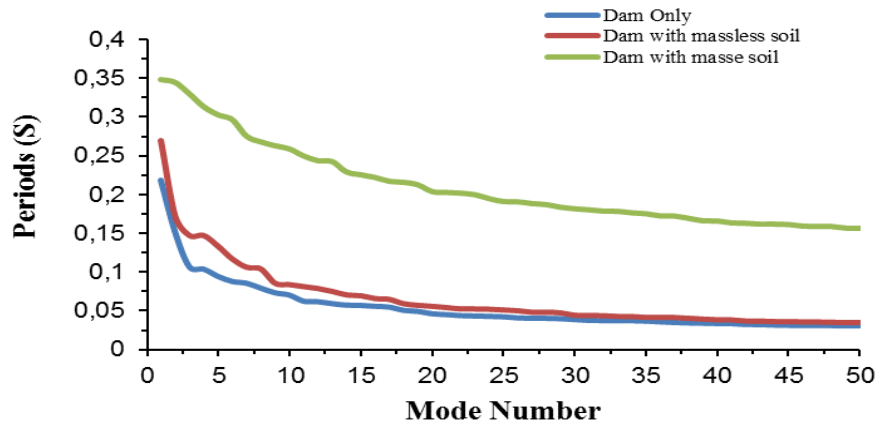


Fig. 3 Effect of soil-structure interaction on behavior

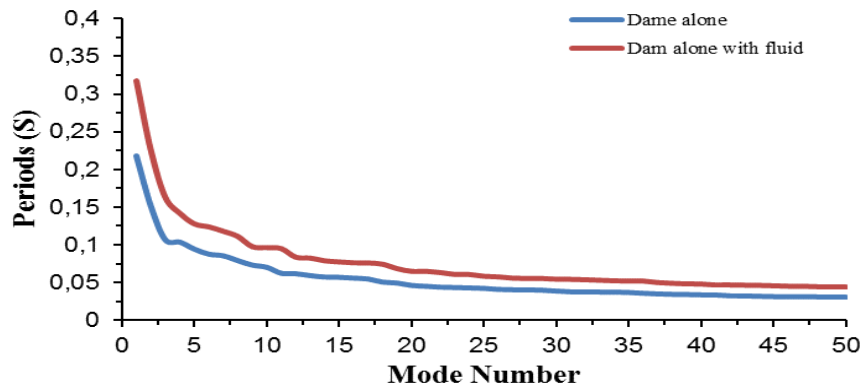


Fig. 4 . Effect of fluid-structure interaction on behavior

It is clear from figure 3 that the period of the dam increases when the subgrade is taken into account, much more when the soil of foundation is modeled with its mass. Add foundation soil to the structure, makes the system flexible and increases its mass which generates a decrease in system frequency and consequently an increase in its period.

Figure 4 shows the effect of fluid structure interaction modeling on the modal behavior of the dam alone, i.e. without soil-structure interaction modeling. It is clear in Figure 10 that the presence of the fluid increases the periods of the system.

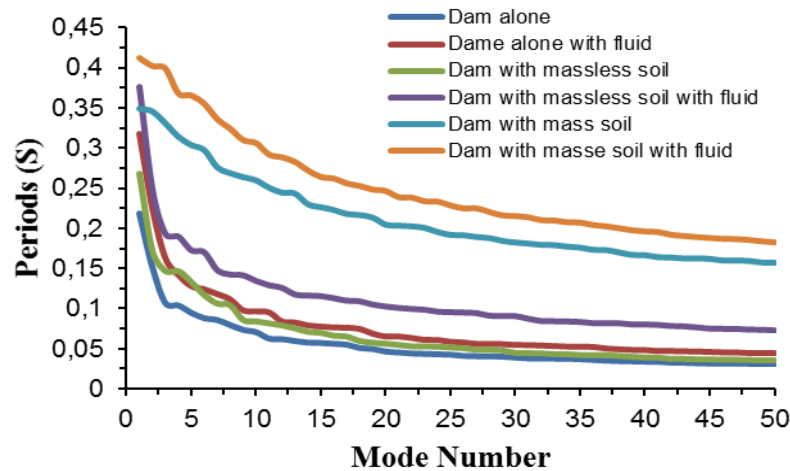


Fig. 5 Effect of Soil-fluid-structure interaction on behavior

Figure 5 represents the effect of interaction soil-structure and the presence of the fluid. it shows that the modeling of ISS as that of the fluid have the same effect on the modal behavior is to increase the periods of the system.

Conclusion

The modeling of soil structure interaction modifies the periods of the dam, knowing that the period is a dynamic characteristic to be taken into account in the different types of dynamic calculation (spectral, transient ...)

The study had shown that reservoir water presence and soil foundation modelling have the same effect on the modal periods results which means on the modal behaviour of the concrete dam, they increase the periods values.



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